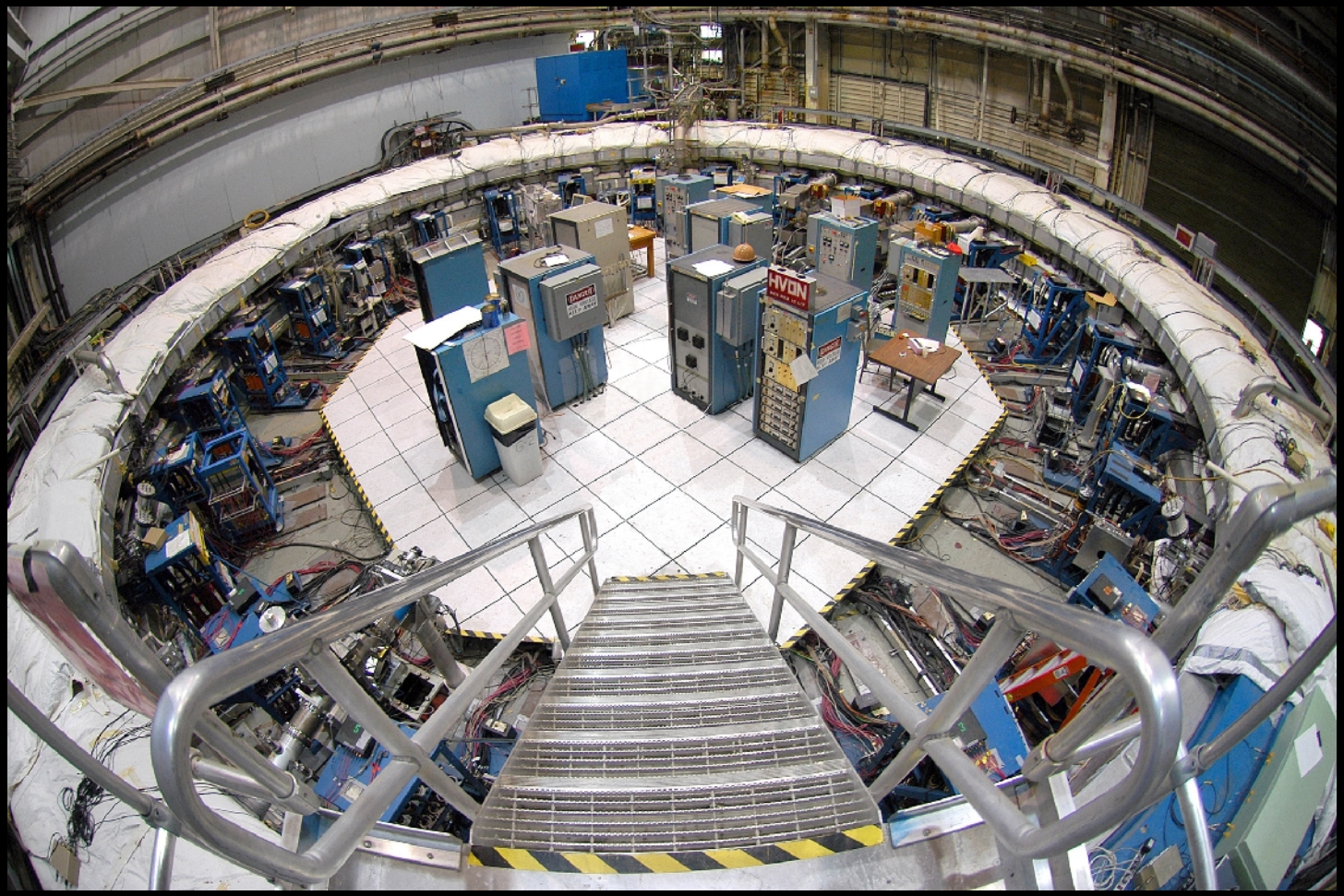
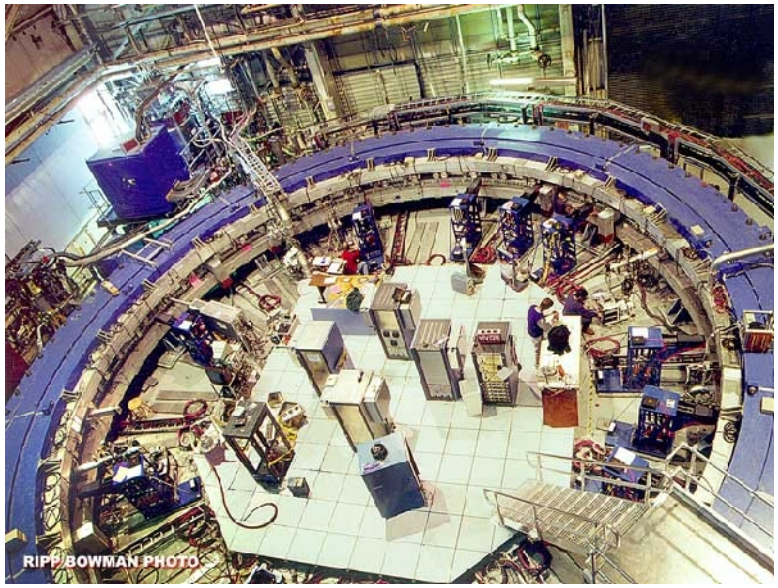
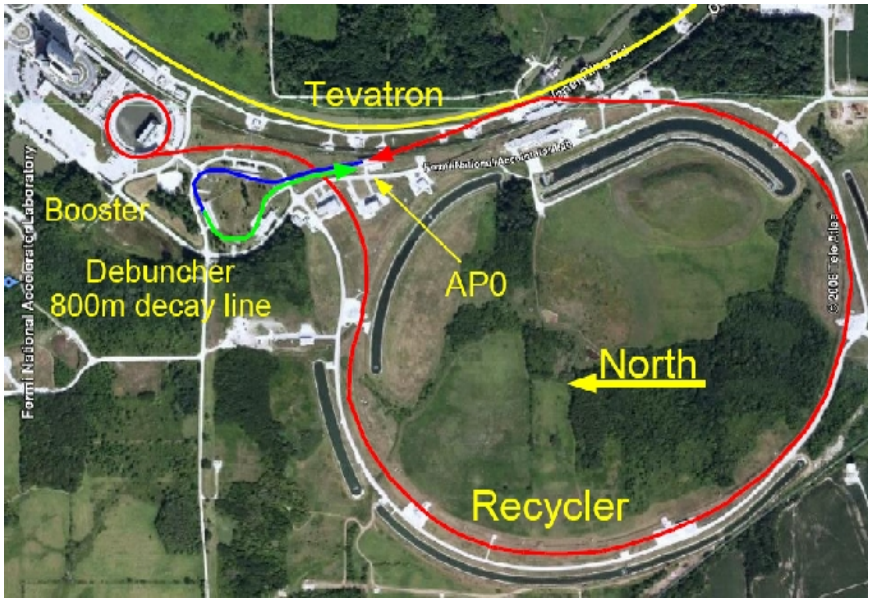
T1005: Muon g-2 Calorimetry Tests at the Test Beam Facility

Chris Polly, Fermilab



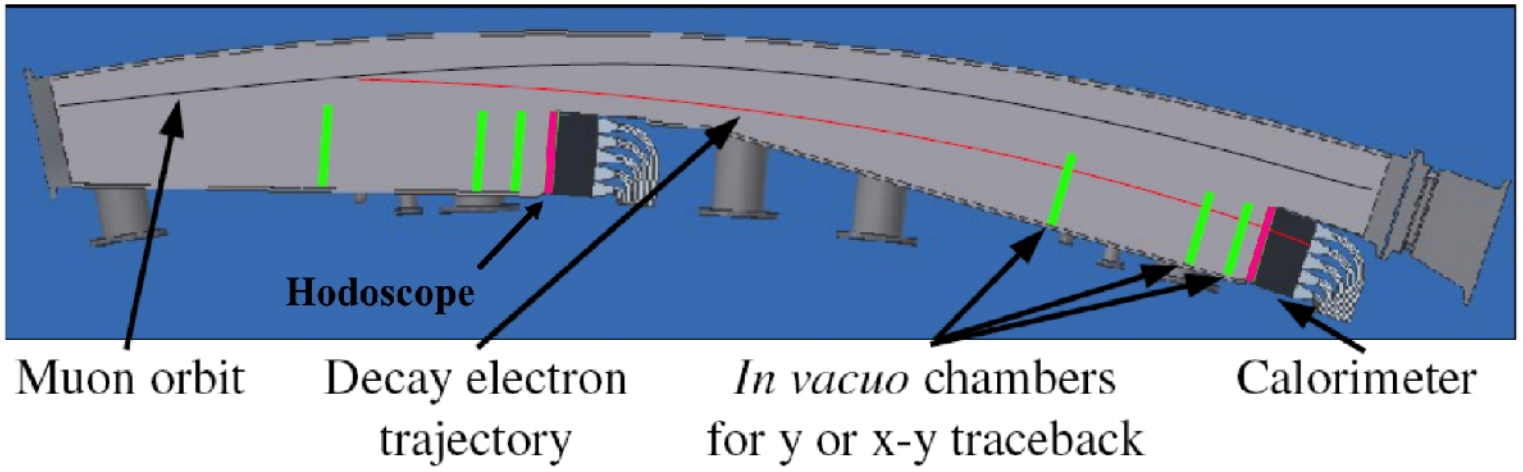
Muon g-2 at FNAL in One Slide

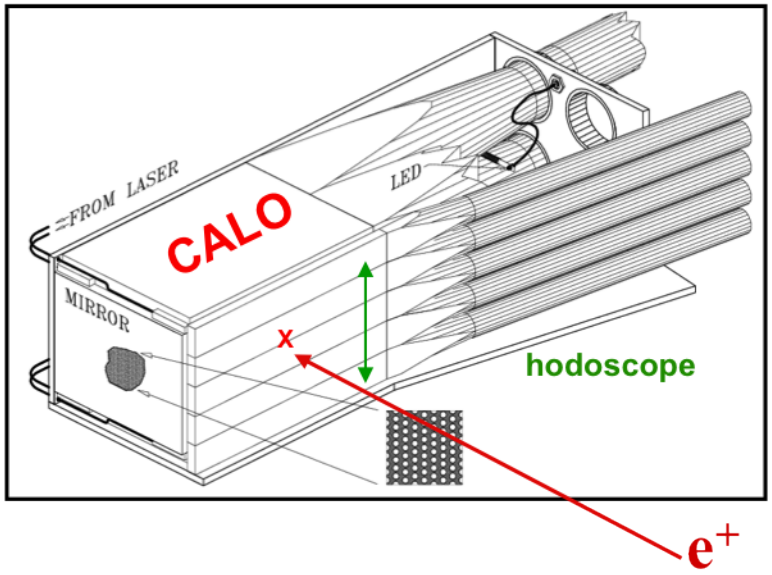




'Simple' plan: Bring muon g-2 apparatus from BNL and set it at the end of a FNAL beamline for 20x muon intensity

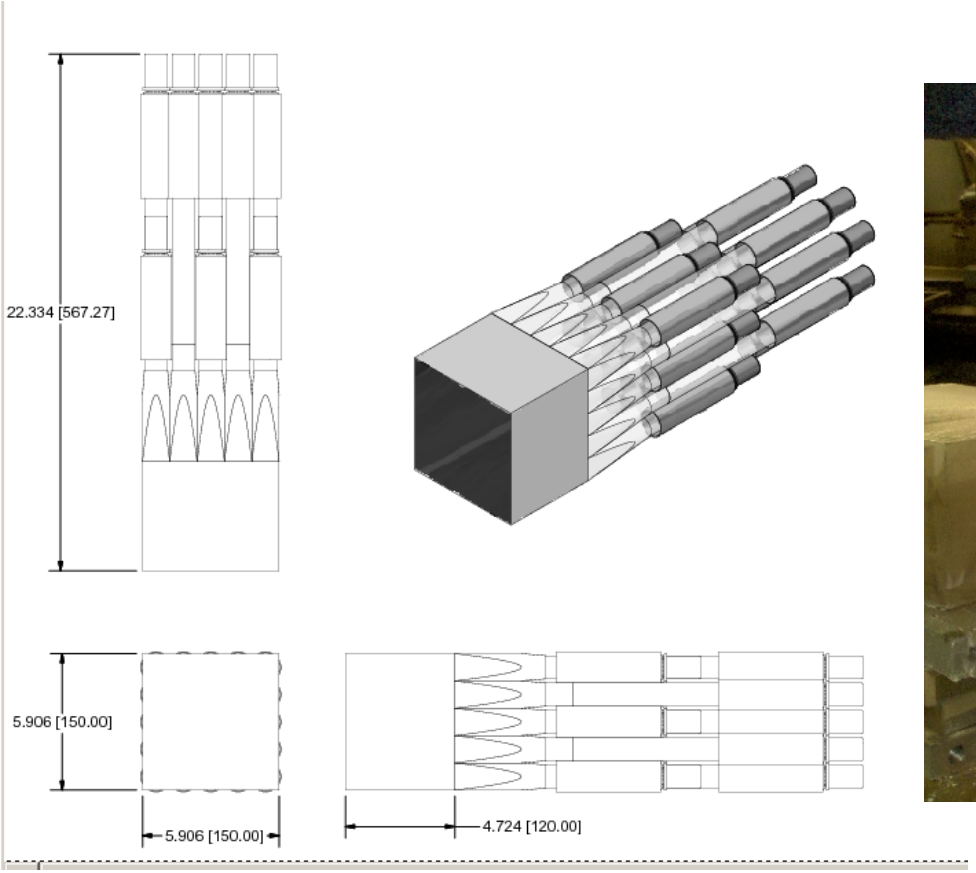
Overview of Detector Systems

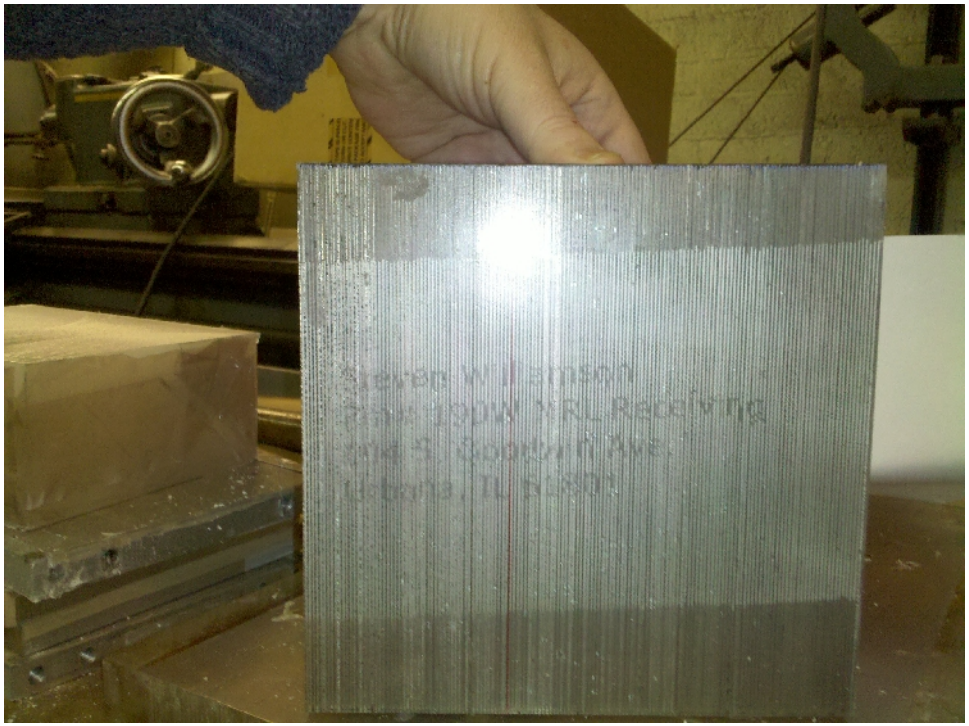




- Decay electron direction in original g-2 was perp to fiber, good for sampling bad for pileup
- In FNAL design fibers pitched at 5 degrees from 3 GeV incoming electron
- Testing a compact segmented W/SciFi design
  - Test energy resolution/light yield with 0.5-4 GeV electrons
  - Function of angle wrt beam
  - Moller radius, efficiency of pileup separation
  - Other data: pulse shapes, light loss at boundaries, albedo, SiPM readout...

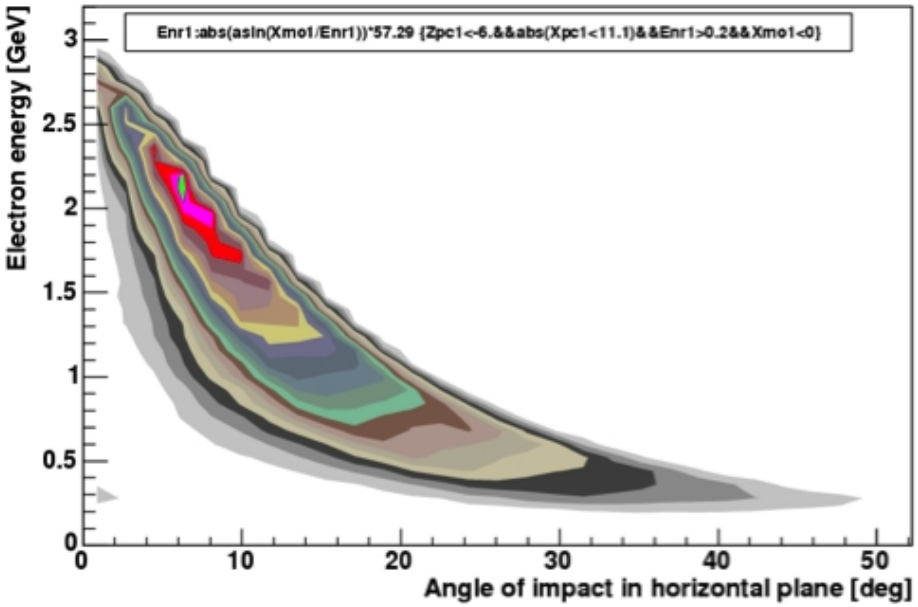
W/SciFi Calo Specs



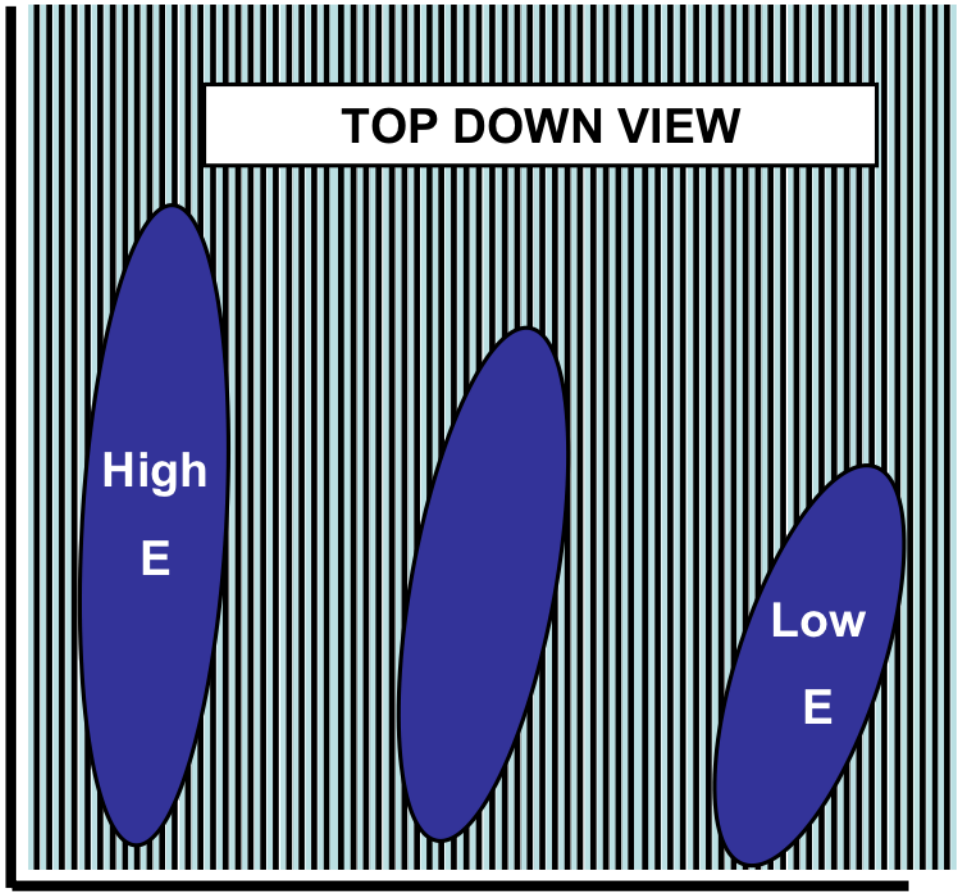


- Original calorimeters used Pb-scifi (15cm x 22cm and 15cm deep) readout by four 2” PMTs, outputs summed in 2x200 MHz WFD
  - W/SciFi prototype 15 cm x 15 cm and 12 cm deep read-out in 3cm x 3cm blocks
- Alternating layers of 0.5 mm tungsten plate, with 0.5 mm diameter fiber ribbons

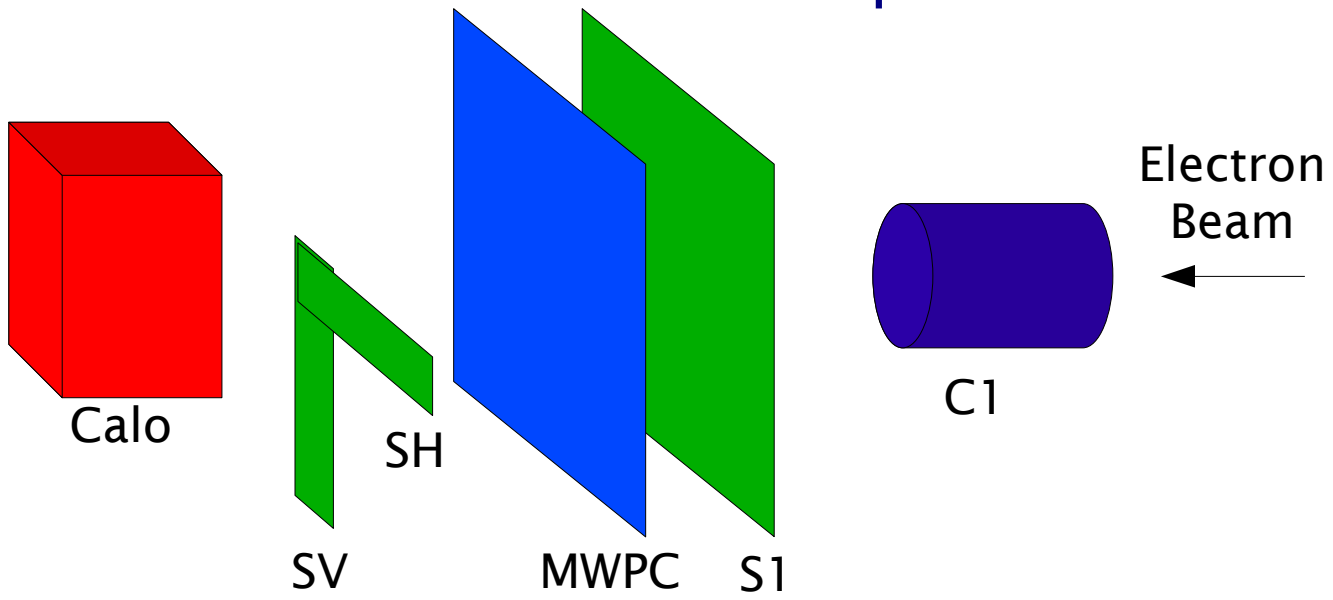
Impact angles of muon g-2 decay electrons



- Low energy electron enter calorimeter at larger angle
- Currently plan to pitch the fiber direction at -5 degrees

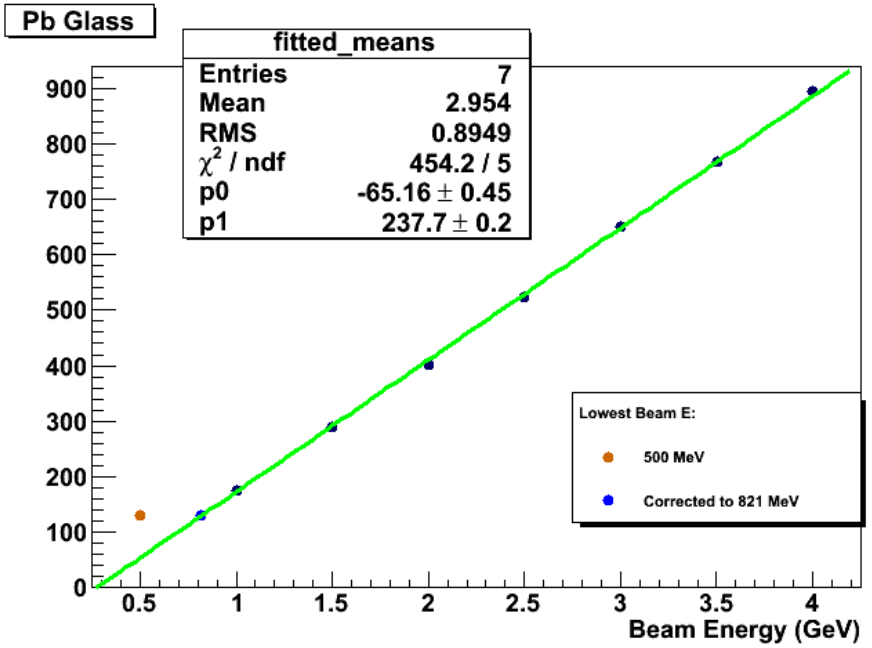


Test Beam Setup

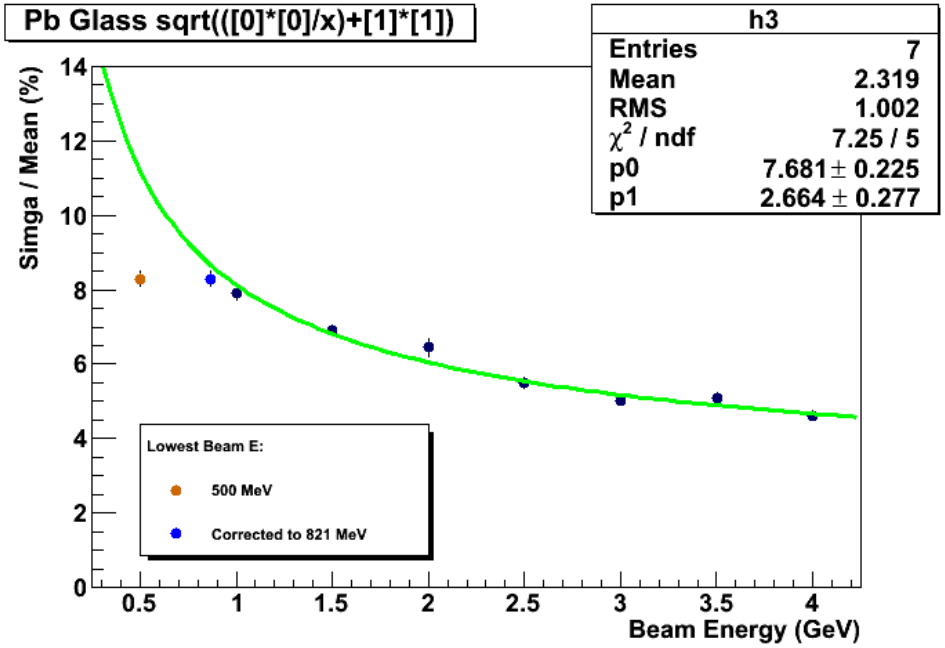


- Cerenkov counter (C1) upstream, everything else like scintillators (S1, SH, and SV) and wire chamber (MWPC) within 0.5 m of calorimeter. 120 lb calorimeter on x-y translation table.
- DAQ trigger on S1or SH⊕SV, C1 veto applied later to remove pions.
- S1, SH, and SV also readout in CAMAC 2249A ADC
- Calo outputs readout in CAMAC 2249A ADC
- Used Eric Ramberg's DAQ developed for TBF and MIDAS
- Used a Pb glass facility calorimeter to 'calibrate' beam

Data on Pb-Glass 'Calibration' Calorimeter

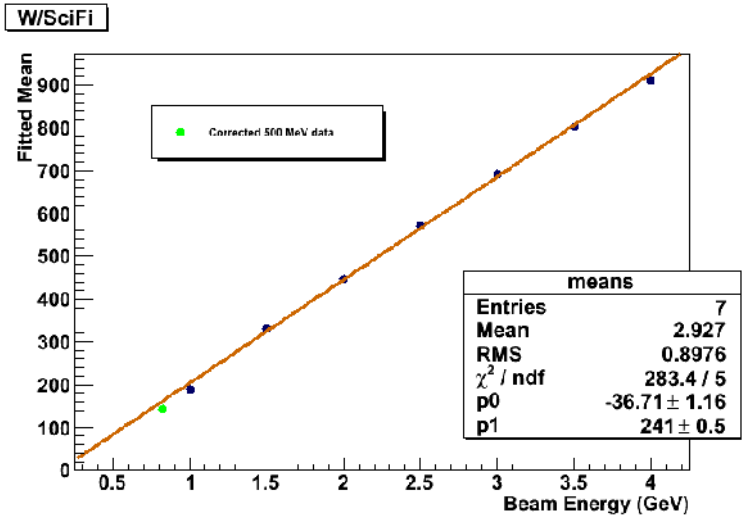


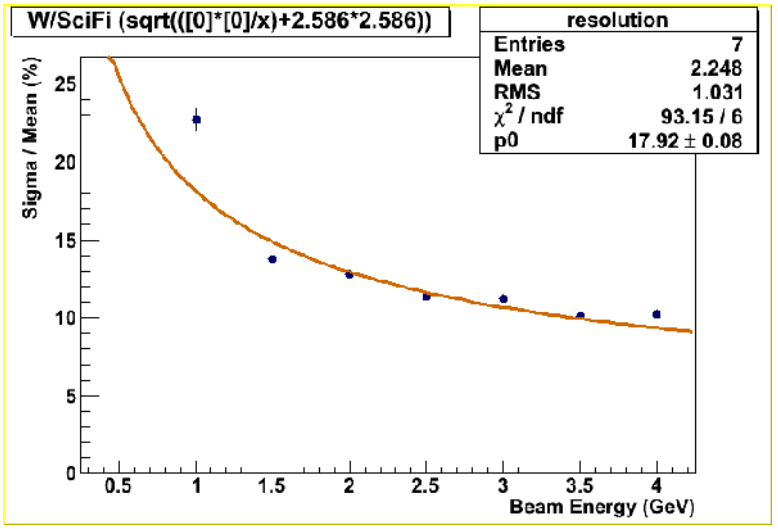
- Were warned '500 MeV point' would be difficult and expect 700-800 MeV...turns out lowest energy was ~820 MeV
- Tracking down a few minor issues
  - Seems to be a negative offset
  - Some points not perfect
  - Checking field probe data



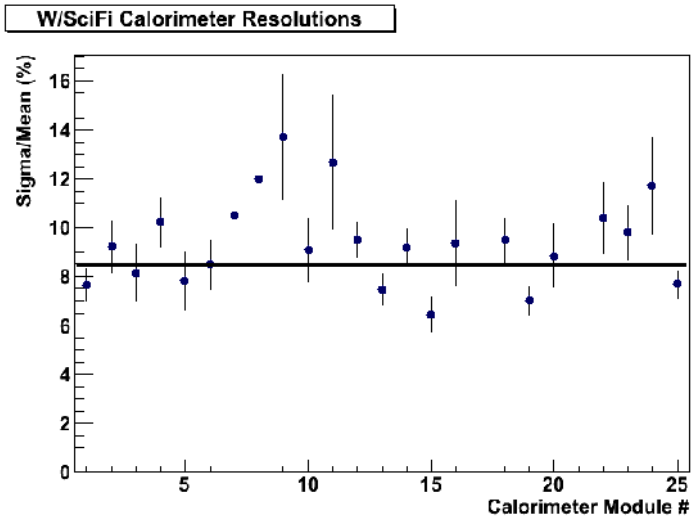
- Found beam to have 2.7% spread
- Small compared to expected energy resolution of W/SciFi (10-12%)

Data on W-SciFi Calorimeter

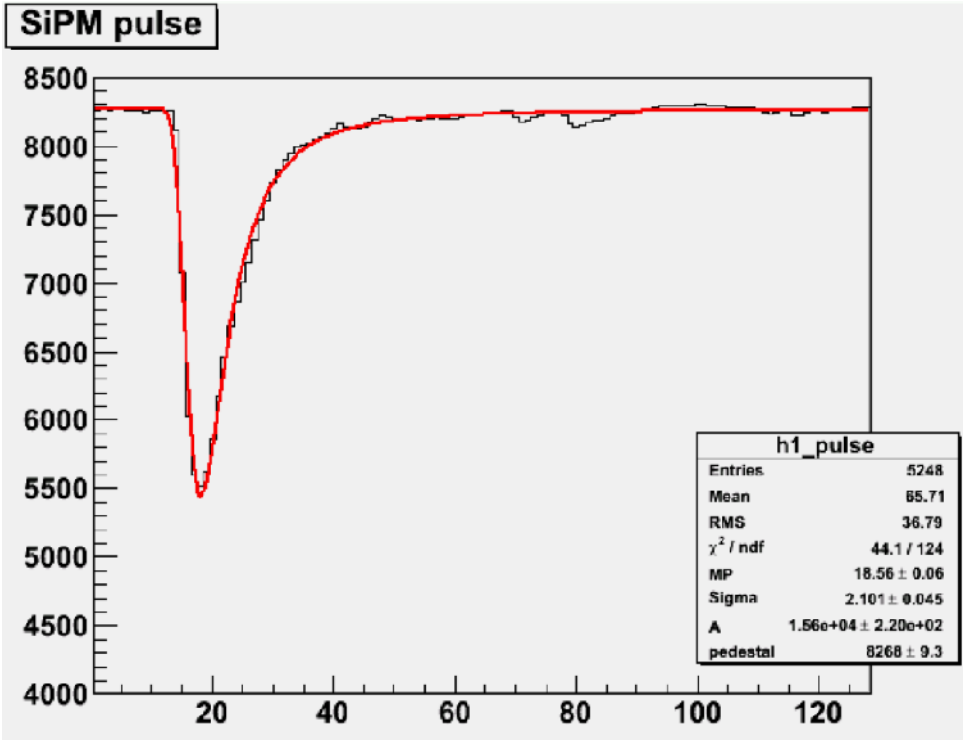




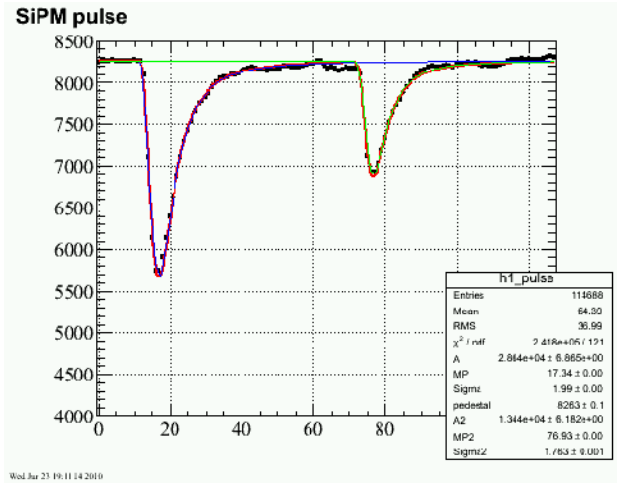
- Energy resolution for each segment measured
  - Still some oddities to understand
  - Overall, energy resolution and containment of W/SciFi looks as expected from simulation
  - Sigma/mean shown at right taken at 2 GeV

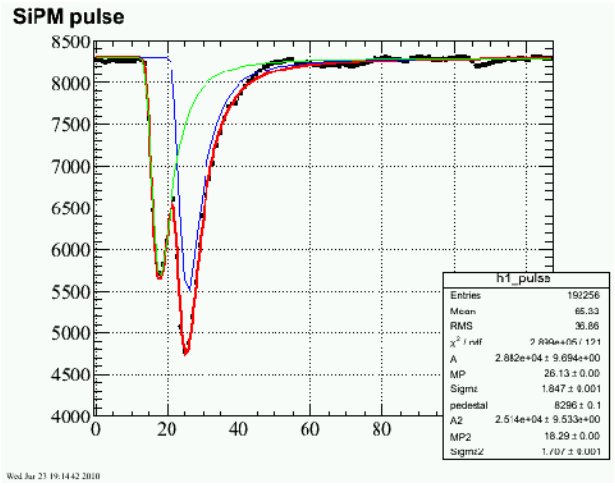


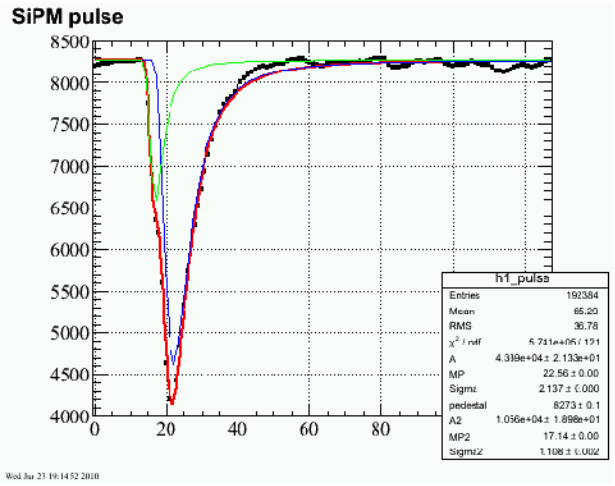
Results with SiPM



- Thanks to Paul Rubinov and Adam Para, we has one channel equipped with a SiPM readout
  - Similar energy resolution as PMTs
  - Nice pulseshapes, 10 ns width
  - Studies to understand ability to separate 2 pilup event just starting

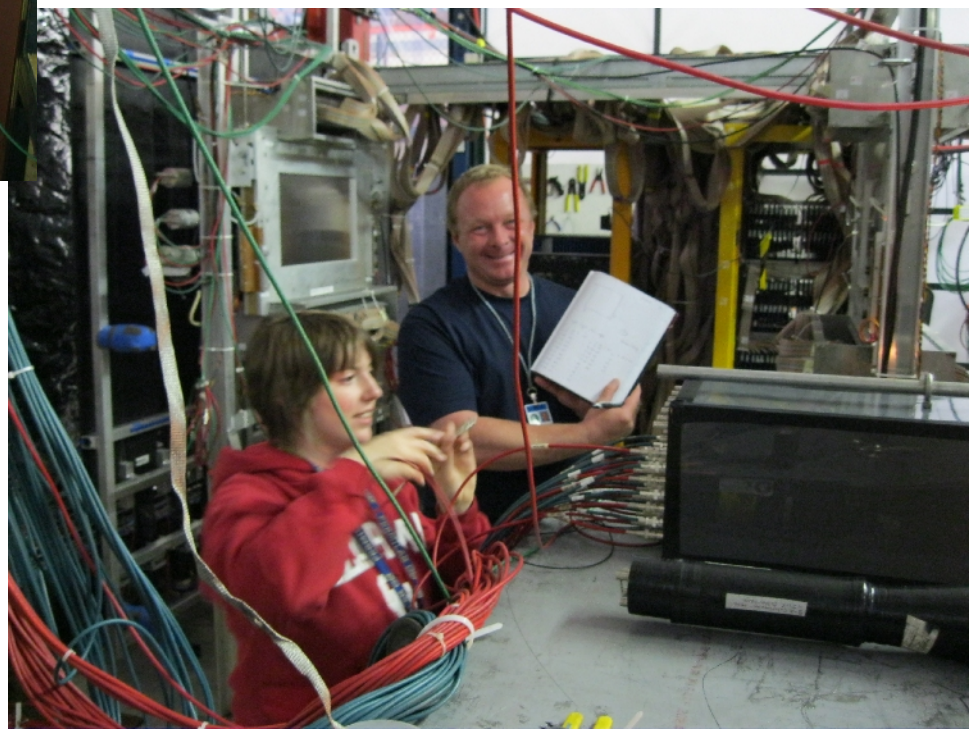






In conclusion...

- Great experience for everyone involved...can be hard in HEP for young people to gain experience
- TBF is a great place to learn about connectors & NIM crates & CAMAC & homemade DAQs & how to debug an experiment (it's always a flaky cable/connector)



Thanks to Aria, Doug, Eric, & Todd for getting us up and running...looking to get the NIM out by the end of the year!